

**Epistemologies of Intention: Uncertainty and Translation in
Bertolt Brecht's *Life of Galileo* and Michael Frayn's *Copenhagen***

by

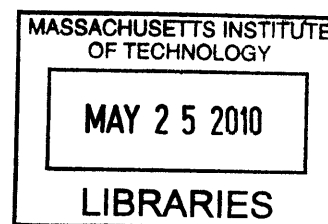
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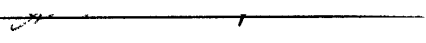
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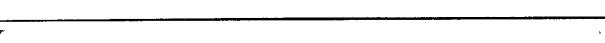
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Introduction

Translating science as dramatic tradition

Scientific and literary traditions are curious bedfellows. Popular perception views contemporary scientists – especially those interested in mathematics or physics – and their occupation as fundamentally other and unknowable to a non-scientific audience. This viewpoint has led to a bizarre treatment of science and its practitioners in literary and dramatic works as most depictions of science in print are restricted to the realm of speculative science fiction geographically and chronologically removed from the author's own time. Those authors or playwrights who do take historical or contemporary science as their subject must present it in such a way that the science is made accessible to a diverse audience. This presentation is particularly important in the theatrical medium.

Playwrights have integrated science with drama in a host of different ways, whether as a plot device or thematic concern. I will study plays that entertain broad thematic questions about the nature of truth and morality while still maintaining their focus on the scientific community and its scientific concerns, especially as these concerns intersect with those of society at large. My analysis will focus on two plays that use science more than rhetorically: Bertolt Brecht's *Life of Galileo* (editions published in 1937; 1945; 1953) and Michael Frayn's *Copenhagen* (1998). Although these two plays were written and produced more than fifty years apart and the historical events that they examine are over two hundred years removed from each other, both explore paradigm-shattering moments within physics research. I will argue that both plays use physics to examine, broadly, the

responsibility that a scientist has to involve himself with the non-scientific community. Characters in both *Life of Galileo* and *Copenhagen* make a case that part of the scientist's responsibility lies in presenting science to the laity, both inside and outside the world of the play. The semantic shift involved in making scientific concepts both understandable and relevant within a dramatic context involves a movement on the part of the playwright and his characters that is, I shall suggest, similar to an act of translation.

Translation is generally conceived of as purely linguistic, which might be described as an attempt at transmitting meanings across language barriers or a linguistic shift seeking to conserve the sense of a written text in a second language. In his seminal work "The Task of the Translator," Walter Benjamin sees translation as something more than a direct word-by-word transposition from one language to another. Instead, Benjamin posits that the translator endeavors to elevate his project beyond changing signifiers between tongues. A true translation moves past linguistic accuracy as an end point; instead, it identifies a higher meaning that the original text points to and creates a new text from that original.

Benjamin's theoretical re-assessment of the task of the translator as one of unlocking meanings extends its boundaries to include the translation of different kinds of discourse into literary or dramatic forms. The plurality of central characters from *Life of Galileo* and *Copenhagen* belong to a scientific, not literary tradition. Although they conceive of their investigations philosophically, even this attitude requires a shift in thinking from an empirical or theoretical viewpoint to a more poetic one.

Theorists and even non-academics have noted that the language of science involves a distinct set of signifiers that is highly metaphoric and symbolic. Mathematical formulae rely on a scientist's ability to perceive the inner workings of the world as numerical and then to further abstract from those numbers to abstract signifiers, the Greek *pis* and *sigmas* and the well-known "x" that appears in even the most fundamental of algebraic problems. This kind of abstraction is itself a translation that moves the scientist from observation to description and then understanding.

Undertaking an act of translation requires a unique kind of mind – which I will refer to in shorthand as a "scientific mind" – which involves being able to conceive of the world around it in a more purely scientific way. The translation involved in viewing things scientifically is implicit within those of Brecht's and Frayn's characters who are presented to the audience as fully formed and educated scientists. For characters like Brecht's Andrea, however, that transition – from curious bystander to member of the scientific community – actually occurs onstage.

The scientific mind, therefore, as seen within Brecht's and Frayn's plays, requires the ability to translate understanding from observations of the natural world to a scientific or mathematical understanding of those phenomena. I argue, therefore, that truly responsible science requires something more than the ability to translate *into* scientific understanding; it demands too a route from esoteric scientific knowledge back into a vernacular. As Benjamin intended, translation becomes a way of unpacking meanings deeper than either original form; it can illuminate questions of essential human nature.

In each of the plays examined here, translation mediates the scientist's interactions with society. Galileo presents it as a way for scientific tools and thoughts to be used to benefit to common people; in *Copenhagen* for example, it is Heisenberg's inability to translate and therefore understand his equations that narrowly prevents him from potentially creating a deadly nuclear weapon for Hitler. The two plays focus on very distinct moments in physics – empirical observations of the planets versus theoretical models of a subatomic universe – and so the physicists' modes of translation are also unique. While Brecht's Galileo relies on explanation bolstered by visual proofs, Frayn's Bohr emphasizes the use of "plain language" as a way of parsing the implications of abstract equations.

The plays are undeniably vastly different when it comes to both the scope of their science and dramatic form; the reason for this difference can be located in authorial intention. Brecht, a life-long committed Communist and social radical, is remembered for advancing the technique of epic or dialectical theatre, a style that sought to counter the melodramatic realism pioneered by the actor and director Constantin Stanislavski. Epic theatre is the theatre of the people, appealing to their reason while advancing the cause of social change. *Life of Galileo* uses the techniques of this epic dramaturgy; its goals are social, political and didactic in nature.

Copenhagen is, by contrast, less informed by ideology than by the idea of intention itself: Frayn frames the play as an exploration into his historical character's motivations at a mysterious meeting in Copenhagen during World War II – the meeting itself is historical fact, although what transpired remains a mystery. The play begins by asking a simple question: why did Heisenberg come to

Copenhagen in 1941? Through the drama, however, Frayn expands his investigations into a full study of how intentions are manifested through acts of scientific study; through an act of thematic mimesis, the more the audience attempts to unravel the characters' intentions, the more those intentions become unclear. *Copenhagen's* dramaturgy makes this complication explicit through its use of the Heisenberg Uncertainty Principle as a structuring metaphor.

In parsing intent, Frayn's audience and Brecht's find themselves in a similar position: perhaps due to the numerous revisions Brecht made of the play, Galileo's character embodies a slippery position with respect to his translation and the audience. Unlike Frayn, however, Brecht makes his intended readings of the character clear, creating uncertainty and tension between the audience's reading of the character and the playwright's intentions.

Chapter 1

The “Original Sin” of Physics: Translation and the moral practice of science in Bertolt Brecht’s *Life of Galileo*

Life of Galileo is one of Brecht’s most enduringly popular works, and one of his most frequently performed. It is also one of his most critically divisive. Taking as its subject Galileo Galilei’s proof with a telescope of the Copernican planetary system and its implications and drawing upon historical, scientific and epic dramatic traditions, *Life of Galileo* might be charitably said to contain multitudes; a more critical voice might call the play muddled. Eric Bentley, one of Brecht’s most prolific scholars, has been a particularly vocal in his criticisms of the piece, taking Brecht to task for playing fast and loose with the historical canon in order to further his own thematic agenda about intellectual freedoms. Bentley asserts that Brecht’s claim – that Galileo’s new empirical investigation might have opened the door to a paradigmatic shift in humanity’s ontological understanding of itself – is in itself based on a misconstruction of the state of physics in Galileo’s period:

In short, [Brecht’s] scientist notices, in a down-to-earth way, what actually goes on: he accepts the evidence of his senses.... What actually happened to physics in the 17th century is that it became mathematical. This meant that it became, not more concrete, but just the opposite.¹

Bentley’s accusations of inaccuracy are numerous and yet all, in the end, come back to reading of *Life of Galileo* as a historical chronicle. Brecht’s misappropriation of the

¹ Bentley, Eric. *The Brecht Commentaries, 1943-1980*. Grove Press; London: Eyre Methuen, 1981. Print. All citations after the first will be parenthetical.

historical, first by attributing the paradigm of empirical science to Galileo and then by remodeling Galileo's personality to fit a political agenda, leads to emphasizing a social message at the cost of historical truth.

Nonetheless, despite his criticisms, Bentley also admits that, "like *Saint Joan*² and all other good history plays, *Galileo* is about the playwright's own time" (Bentley, 186). That is, the playwright's use of history expands beyond the limits of the period he represents in order to visualize the social concerns of his present, which underwent a radical re-evaluation during his lifetime. Brecht's shifting socio-political concerns led to at least three complete variants on the theme of *Galileo*. The play's original version, written before the Second World War and first performed in Berlin, differs significantly in tone from later editions. The playwright writes Galileo as a cunning trickster, who defies the strictures of his house arrest in order to finish his *Discorsi*. The atomic bomb dropped on Hiroshima and Nagasaki, prompting the end of the Second World War had, however, immense consequences for Brecht's conception of science in general and his Galileo in particular. The first version of *Life of Galileo* reads as a demand for intellectual freedom, the right of the scientist to research anything. In contrast, both the English-language production, on which Brecht collaborated with the actor Charles Laughton, and the later Berliner Ensemble production³ cast Galileo in a much more negative light. Instead of being presented as cowardly but cunning, this Galileo castigates himself for having betrayed science, the community of scientists, and the world at large by so easily

² *Saint Joan* is George Bernard Shaw's play about Joan of Arc; a formal comparison has often been made between the two, including the title characters' persecution by the Catholic Church.

³ Translated into English by John Willett.

abandoning his convictions. With this accusation, Brecht combines his historical message with resonances of his contemporary concerns in order to offer his audience a critical examination of the moral practices of the science of his day.

It is at this point, however, that the author's critical purpose operates at odds with the audience reaction: while Brecht explicitly hopes that the audience will recoil from Galileo in horror at his actions, viewer sympathies have historically stayed with the scientist to the end. In the most famous English-language performance of the character, Charles Laughton's portrayal in particular obscured Brecht's intent: he was said to act the character in a way that made the audience pity rather than abhor his final disgrace. Brecht's writings indicate that he recognized the gulf between the play's intentions and execution, remaining dissatisfied with the play's form until his death:

LG is technically a great step backward... too opportunistic. One would have to rewrite the play totally if one wanted to have this 'breeze that comes from the new shores,' this rosy dawn of science. All more direct, without the interiors, the 'atmosphere,' the empathy. And all directed toward planetary demonstration. The composition could stay the same, the character of Galileo, too (Thompson 139).⁴

Brecht condemns *Life of Galileo* for its empathy and seems to regret its ability to draw in the audience, which he attributes to "the interiors, the 'atmosphere,' the empathy." His idealized, never-realized *Galileo* would be a far more minimalist

⁴ Thomson, Peter, and Glendyr Sacks. *The Cambridge Companion to Brecht*. Cambridge University Press, 2006. Print.

affair: only by directing the entire purpose of the play towards “planetary demonstration” would he be able truly to express a utopian future for science.

The notion of “planetary demonstration” is key to Brecht’s ideal work, a concept that has implications both within the drama and without. It implies a visual component to Galileo’s project that is echoed by the importance of the telescope, both as a literal tool of scientific investigation and as the symbol for technological and social revolution (as it is used in Scene 10 at the fairgrounds⁵ and with Galileo’s repeated insistence that the skeptical see the truth of the telescope for themselves). At its heart, even this focus on the visual evokes translation from a scientific realm to a more vernacular one: Galileo’s visual proof is the ultimate result of moving an inherently scientific and numerical language – one that is largely theoretical – into the realm of the visual and concrete. This movement, from abstract theory to visual evidence, accompanies a shift in the play’s science from a scholarly language, Latin, to the vernacular, and from an academic discourse to a populist one.

For the non-scientific characters within the drama, Galileo’s planetary demonstration is the way that he introduces them to the world of scientific investigation in general, but most particularly to his proof of the Copernican solar system. For the similarly non-scientific audience, who might be fairly expected to be familiar with a heliocentric model of the planets, “planetary demonstration” speaks more to their understanding of the scientific project in general – the “real world” or existential consequences of Galileo’s science. The revised *Life of Galileo* that Brecht

⁵ From the stage directions of Scene 10: “On an absurd throne sits the ‘Grand-Duke of Florence,’ a figure with a cardboard crown dressed in sackings and looking through a telescope. Above his throne a sign saying, ‘Looking for trouble’” (Brecht, 85).

posits above would expand the planetary demonstration that is already present in the extant versions of the play.⁶ In his assessment, at least, it is this act of translation that is drama's true heart. With this emphasis on translation, which is critical for scientists and non-scientists alike, Brecht calls through Galileo for a new practice of science that is far more than simply empirical: it is moral.

Moral science, as posited by *Life of Galileo*, is science explicitly for the people and by the people: science that improves the quality of their lives, either technologically or intellectually. Brecht's Galileo is always adamant about its central role in a world of new ideology. The role of *scientists*, on the other hand, is less immediately clear. Between curtain rise and fall, Galileo first establishes his position on the importance of scientists and then, by the end of the play, changes his views based on his own perceived failures. Galileo is not just a scientist, but also an educator, a position that demands his engagement not only with the scientific community represented by his assistants and collaborators, but also with the non-scientific *dramatis personae* and the audience. Brecht locates this act of education as occurring through translation from scientific thought into the vernacular. When he condemns Galileo as a traitor, it is because he reneges on his defense of the truth in order to save himself from torture: his willingness to capitulate to the Inquisition has given rise to a practice of science as "knowledge for knowledge's sake," rather than "for the principle that science's sole aim must be to lighten the burden of human existence" (Brecht, 108).⁷ Galileo has proven to the world that scientists can

⁶ The Berliner Ensemble edition will be the focus of this analysis.

⁷ Brecht, Bertolt. *Life of Galileo*. London: Methuen Publishing Limited, 2001. Print.

be “brought to heel by self-interested rulers,” and in doing so, he severs the act of science from the act of translation (Brecht 108).

His devastating self-assessment at Brecht’s hands proves curiously unsatisfying. It is hard to reconcile the Galileo of earlier scenes, who insists on publishing his work in the vernacular and who engages in a nearly continuous act of translation, with his supposedly unequivocal betrayal: the Galileo of these earlier scenes seems almost heroic in scope. By framing the character differently, however – concentrating on his intellectual theft of the telescope design, his unwillingness to engage in education or translation with his daughter, Virginia, his reluctance to be seen as the mouthpiece for worker’s concerns, and his capitulation first to limitations on his research and then to the Inquisition’s demands that he recant – Galileo appears less heroic and more self-interested.

Brecht continually shifts our perceptions of Galileo and his science not only through the character’s behavior but also through the way he frames that behavior within the drama. By emphasizing certain scenes of translation and centering on the moment of Galileo’s recantation on Andrea and his assistants, not on Galileo himself, Brecht creates from his character a constantly moving hermeneutic target. The audience is unsure of how, exactly, to read Galileo’s final speech, especially when juxtaposed immediately with his giving Andrea a copy of the *Discorsi* to smuggle out and disperse to a wider audience. In Scene 14, Galileo claims to Andrea, “creating knowledge for all about all, it aims to turn all of us into doubters” (Brecht 108); Brecht’s shifting characterization imbues the audience with the same impulse to doubt. Once again, however, framing is crucial: Galileo hopes that the common

people will doubt their rulers and those who would attempt to oppress them; in this scene, he is less willing to encourage doubt of his own claims, evidenced by his rejection of the defense that Andrea offers his behavior. Like his character, Brecht creates the occasion for doubt but not the space to question; he flirts with uncertainty but rejects it in favor of politics.

Galileo's dialectic: establishing the need for translation

Galileo is seen throughout the play as both scientist and educator: although he is reluctant to take on students like Ludovico, students who have “not got the brains for science” (Brecht 12), he is nonetheless fond of teaching those like Andrea Sarti, the son of his housekeeper, who demonstrate a clear and sustained interest in the physical sciences. In fact, of all characters in the play, Andrea and Galileo are the most developed and the evolution of their relationship from student and mentor to both physicists and teachers in their own right might arguably be called the play's emotional and dramatic core, even more so than Galileo's actual capitulation to the Church. It is fitting, then, that Brecht writes two of the play's most critical dialectics between these characters. The first, in Scene 1, optimistically establishes the changing scientific paradigms of Galileo's time and advocates for the destruction of old ways of thinking through a thought revolution that takes intellectual power out of the hands of a religious elite invested in maintaining the status quo. By his final speech in Scene 14, his last appearance in the play, Galileo views himself as complicit in the same act of silencing the truth of which he accuses the religious

elite. In both exchanges, Galileo is concerned with how the changing state of physical sciences will impact the lives of the common people. In both speeches he recognizes that the people must wield the scientific tools of their own enlightenment; moreover, by Scene 14 he explicitly acknowledges that scientific knowledge must be transmitted from scientist to layperson, either by the scientist's passively allowing access or by a more active translation. Reading these two scenes together provides a useful way of framing the question of scientific translation in the text so as to center its implications for the common people – one of Brecht's major concerns as a playwright – and a way of understanding the change in Galileo's towards translation as fostered by his dealings with the Inquisition. As we will see, however, his behavior throughout *Life of Galileo* complicates our reading of the final speech somewhat – not Galileo's wider claims, necessarily, but how those claims intersect with his particular responsibility as a scientist.

Galileo's first speech is framed by his demonstration to Andrea of Aristotle's crystalline spheres and the heliocentric counter-hypothesis offered by Copernicus. The claustrophobic nature of those spheres functions as an allegory for a lack of modes of other scientific and technological advancement that might lead to social progress. Just as crystalline spheres trap the earth, preventing it from rolling freely across the sky⁸, so adherence to old constraints on thought stymies progress.

⁸ GALILEO: The old idea was always that the stars were fixed to a crystal vault to stop them falling down. Today we have found the courage to let them soar through space without support; and they are travelling at full speed just like our ships, at full speed and without support. And the earth is rolling cheerfully around the sun... (Brecht 8)

Ironically, the very thinking that asserts that humans are the center of the known universe stifles their potential:

GALILEO: For two thousand years people have believed that the sun and all the stars of heaven rotate around mankind. Pope, cardinals, princes, professors, captains, merchants, fishwives and schoolkids thought they were sitting motionless inside this crystal sphere. But now we are breaking out of it, Andrea, at full speed. Because the old days are over and this is a new time. For the last hundred years mankind has seemed to be expecting something.

Our cities are cramped, and so are men's minds (Brecht 6).

Galileo longs to establish the truth of the Copernican planetary model, which places the sun, rather than the earth, at the galaxy's center. He demonstrates the Aristotelian model to Andrea, who observes: "That's great. But we're so shut in" (Brecht 6). Galileo responds with the agreement, paving the way for the play's first major didactic moment: "Yes, I felt that the first time I saw one of those. We're not the only ones to feel it" (Brecht 6). For a scientist like Galileo, skeptical of religious dogma, being centered in the Aristotelian model doesn't comfort humanity but confines it, holding it "motionless inside this crystal sphere." These spheres metonymize the restrictive status quo of Rome's Catholic regime, bound by centuries of tradition, while his speech recognizes an increasing popular willingness to deconstruct old ways of doing things, a new attitude that he hopes will lead to a more extensive revolution. Importantly, too, the new curiosity and skepticism that Galileo envisions in the common people is depicted as explicitly positive: while the

Little Monk in Scene 8 worries that decentralizing mankind in the universe will make human struggles through grinding poverty and iniquity seem pointless, Galileo wonders why they must so struggle at all.

As initially presented in Scene 1, the revolution Galileo hopes for seems more social than scientific. Although he locates the seeds for change in a cast of characters from all walks of life – “professors, captains, merchants, fishwives and schoolkids” – the larger thrust of his speech concentrates on the effects of a thought revolution on workers and peasants, and the pragmatic benefits that technological advancement will bring – enabled by the worker’s newly questioning outlook. In “Heavenly Food Denied: *Life of Galileo*,” Darko Suvin sums up the thematic thrust of this monologue, and the play as a whole: “The play’s horizon is one of skillful tactics against the rulers”.⁹ Galileo centers his understanding of changing attitudes on ships and dockworkers, which become the signifiers of a new world order:

GALILEO: I like to think that it began with the ships. As far as men could remember they had always hugged the coast, then suddenly they abandoned the coast line and ventured out across the seas. On our old continent a rumour sprang up: there might be new ones. And since our ships began sailing to them the laughing continents have got the message: the great ocean they feared, is a little puddle (Brecht 6).

⁹ Suvin, Darko. "Heavenly food denied: Life of Galileo." *The Cambridge Companion to Brecht*. Peter Thomson. Cambridge, UK: Cambridge University Press, 1994. Print. Subsequent citations will be parenthetical.

By evoking the ships as the harbingers of change, Galileo emphasizes the physical and technological benefits of scientific curiosity and explores a kind of pragmatic revolution. These tangible changes in the lives of the common people – ships leaving the shore, new continents being discovered – pave the way for a more abstract scientific curiosity and a desire to know more about the world than they had previously been told. In Galileo's mind, the ships become metaphoric, embodying the full potential for change contained within a scientific revolution.

If one paradigm is overturned, Galileo asserts, others will follow. By leaving familiar shores for the vast unfamiliarity of the ocean, people have proven that they are no longer willing to settle for received wisdom; their new-found critical doubt will lead to an interest in other modes of change and exploration and in particular, in physical science. "And a vast desire has sprung up to know the reasons for everything," Galileo says, "why a stone falls when you let it go and why it rises when you toss it up" (Brecht 7). Here, scientific curiosity is presented as the natural and expected result of shifting social attitudes and experiences, not the instigator.

Galileo associates change first and foremost "with the ships," and by extension with the men who helm those ships; later he says, "as a young man in Siena I watched a group of building workers argue for five minutes, then abandon a thousand year old method of shifting granite blocks in favour of a new and more efficient arrangement of the ropes" (Brecht 7). In both cases, the technological discoveries that lead to change originate within the same class of workers and common people who might benefit from a social revolution as well.

Critically, the brand of empiricism that Galileo presents excludes a scientific translator by its very form: if scientific knowledge is to be *discovered* by the people through observation, then it does not need a translator to present it. He sums up the enlightened attitude towards the so-called common knowledge that defines the era before ideological revolution: “Everyone says: right, that’s what it says in the books, but let’s have a look for ourselves” (Brecht 7). This attitude favors an approach based on a “look-and-see” approach that is echoed throughout the play by Galileo’s constant exhortations to look, to see, and by extension to understand.

Ironically, Galileo minimizes the value of scientific translation even as he is engaged in what is unequivocally an act of said translation with Andrea – intellectually curious and already a practiced skeptic at ten years old – by attempting to prove to him the truth of Copernicus’s heliocentric model. Andrea’s willingness and ability to mount a defense of his position, while still being susceptible to a convincing proof, make him an ideal vehicle for the translation that Galileo in fact engages in throughout the play. His relationship with Galileo follows a traditional model of apprenticeship, creating a space that allows for their dialectical relationship to spin out over the course of the play. In this scene, Andrea fulfills the other half of the didactic pair that Brecht uses to explain scientific theories.

Having characters debate two opposing viewpoints for the audience’s edification is a common Brechtian device and in the first lines of the play, Andrea is pitted against Galileo in a similar fashion: while Galileo supports the Copernican model of the universe with an eloquent defense, Andrea demonstrates the traditional, religious commoner’s view of the universe – a view based largely on

what seems like common sense, although it slots in neatly with the Aristotelian model of the universe supported by the Church and opposed by scientists. Andrea counters Galileo's theoretical proofs with his visual ones, as when he says, "But I can see with my own eyes that the sun goes down in a different place from where it rises. So how can it stay still? Of course it can't" (Brecht 109). In the end, though, Galileo's act of translation achieves its purpose: Andrea is convinced of the Copernican truth and becomes inducted into the community of scientists.

By juxtaposing a moment of translation with Galileo's dismissal thereof, however, Brecht gives the reader the first glimpses of Galileo's protean nature and the distance he creates between the physicist's words and his actions. Within the action of the play, he will vacillate between positions fiercely: in one moment in Scene 3 rejecting the dogma of the Church to his friend Sagredo,¹⁰ then later putting his astronomical investigations on hold for eight years at the thinly veiled request of then-Cardinal Barberini, later Pope Urban VIII.¹¹ Although he writes and debates exclusively in vernacular so that people like his assistant Federzoni, who speaks no Latin, can understand, he nonetheless seems to resent it when the common folk appropriate his writings for their own purposes: when the ironworker Vanni praises him for being "the man who's battling for the freedom to teach what's new," Galileo protests, "I've written a book about the mechanics of the universe, that's all. What people make or don't make of it isn't my business" (Brecht 88). In one moment, he seems to champion the people, and yet he rejects any role in their quest to be

¹⁰ SAGREDO: I'm asking: where is God in your cosmography?

GALILEO: Within ourselves or nowhere (Brecht 28).

¹¹ From the rhyming introduction to Scene 9: "Eight long years with tongue in cheek/ of what he knew he did not speak" (Brecht 69)

enfranchised; although even his earliest speech envisions science as a tool for social change, he claims *his* physics as science for science's sake.

When read with his first monologue of the play, Galileo's speech in Scene 14 – wherein he re-evaluates the role that scientists must play as translators and transmitters of information in a social revolution – seems like a dramatic shift in ideology. Having initially asserted that social and scientific change must come by the population that it will benefit, in this case the common people, Galileo goes on to advocate for the scientific community's involvement in the process of revolution. An examination of his behavior throughout the play, however, suggests that Brecht has instilled within Galileo the seeds of both arguments. His behavior can be read as favoring one viewpoint or the other simply based on which scene the reader might chose to focus on: by refusing to be implicated in Vanni's reading of his career, Galileo could be seen to be appropriately removing himself from the arena of social change, whereas by insisting on writing in the vernacular, Galileo is actively introducing his science to the common man in an act of translation. By reading *Life of Galileo's* bookending monologues in conjunction with each other, we can see that act as a sort of dialectic between the scientist and himself. However, by framing the argument for translation as both Galileo's final appearance in the play and as a condemnation of his cowardly and misguided actions throughout, Brecht heavily weights the dialectic in favor of translation.

A population that is doubtful and questioning of dogma is central to Galileo's vision of a more utopian future, a vision not dissimilar to the ultimate goal of epic

theater as outlined in Walter Benjamin's critical assessment, "What is Epic Theater?" Brecht's ultimate goal, asserts Benjamin, is to create a critical, questioning audience:

The didactic play is a special case largely because it facilitates and suggests the interchange between audience and actors and vice versa ... Every spectator is enabled to become a participant.¹²

According to Benjamin, the epic form empowers the audience to think critically rather than rendering them passively emotional. However, didacticism provides the key to maintaining an engaged critical audience: instead of striving for a sense of realism, the playwright creates opportunity for audience reflection through the creation of on-stage dialectics. Even as the audience becomes a key "participant" in the drama, however, Brecht uses techniques of alienation and gesture as a necessary lens through which the audience can focus its critical engagement: his theatrical devices wake up the audience from its comfortably passive position, indicating where they should take stock and consider what is being played in front of them. Without the playwright guiding their interpretations of the project, the audience becomes confused by its vision – it sees, but fails to comprehend. Within the contexts of epic theatre, the playwright uses theatrical devices to act as a kind of translator, the same role that Galileo eventually realizes is essential for the scientist.

Galileo's final capitulation to the Inquisition and his earlier willingness to suspend his work on the orders of the Holy See is presented as the ultimate

¹² Benjamin, Walter. *Illuminations*. New York: Schocken Books, 2007. Print. Subsequent citations parenthetical within the text.

betrayal.¹³ He cannot come to terms with this failure until many years into his house arrest. When Galileo's role in the play comes to a conclusion, however, it accompanies a renunciation of his earlier rejection of the benefits of translation. His final monologue is, like his first, directed to Andrea – now a grown man and a teacher of physics himself. Andrea has internalized Galileo's teachings not only about astronomy but also the practice of being a scientist. He condemns Galileo's recantation as a rejection of the truth but is willing to embrace his mentor once again after learning that he has finished his *magnum opus*, the *Discorsi*, a grand treatise on the state of physics. For Andrea, as for Galileo in Scene 1, the preservation of the truth is the scientist's fundamental goal and the search for truth is an end in itself.

The fully enlightened Galileo of *Life of Galileo's* end rejects Andrea's acceptance. "I betrayed my profession. A man who does what I did cannot be tolerated in the ranks of science," he says (Brecht 109). But whose science? For Andrea as a scientist, only the discoveries matter; Galileo is valuable only insofar as he is the most agile scientific mind of his age: he makes this explicit when he asserts, "Science makes only one demand: contribution to science" (Brecht 107). The Galileo of Scene 1, who has not yet been challenged, interrogated and forced to recant by the Holy See, would seem to agree. His emphasis on a science without books, on the people questioning for themselves, seems to minimize the role of scientist –

¹³ In Brecht's "Notes on Individual Scenes," appended as an afterword to the Methuen ed. of *Life of Galileo*: "...Unlike Copernicus, who had avoided a battle, Galileo fought it and betrayed it" (Brecht 148).

particularly as an intermediary between discovery and general population, a role that has a significant moral component to it as well.

In Scene 14, Galileo reassesses the importance of science in a social revolution. Initially, he presented a flourishing of scientific progress as something that would follow naturally from a change in critical attitudes and a newly questioning mien. Whereas he once thought popular doubting might lead to scientific progress, Galileo now believes that it is the voice of *scientific* skepticism that empowers the uneducated to question their beliefs:

Creating knowledge for all about all, it aims to turn all of us into doubters. (...) Our new art of doubting delighted the mass audience. They tore the telescope out of our hands and trained it on their tormentors, the princes, landlords and priests. These selfish and domineering men, having greedily exploited the fruits of science, found that the cold eye of science had been turned on a primaeval but contrived poverty that could clearly be swept away if they were swept away themselves (Brecht 108).

Galileo describes the scientific attitude as an “art of doubting,” consistent with his earlier statement to Andrea that “[science] deals in knowledge procured through doubt” (Brecht 107). Thus, the change in modes of belief – from surety to doubt – that scientific revolutions enact creates a space in which other things can be doubted. The common people can exploit that scientific doubt in a quest for social change, physically seizing the tool of change from the scientific community and “train[ing] it on their tormentors.” For the first time, Galileo seems to understand

the inextricable link between the sciences and social change, while recognizing that their connection is as dependent on the layman taking what he needs as Galileo offering it.

Elsewhere in his speech, Galileo inextricably connects a willingness to engage specifically in an act of translation with the responsible and moral conduct of science. He suggests in Scene 14 that, “had I stood firm the scientists could have developed something like the doctors’ Hippocratic oath, a vow to use their knowledge exclusively for mankind’s benefit” (Brecht 109). The “Hippocratic Oath” that Galileo/Brecht envisages at the end requires that the scientist take an active role, not only in *using* his knowledge for good but in *transferring* his knowledge through an act of scientific translation. As he acknowledges, any benefit science might grant an uneducated populace is dependent on the scientist’s “revealing” what he knows:

A human race which shambles around in a pearly haze of
superstition and old saws, too ignorant to develop its own powers,
will never be able to develop those powers of nature which you
people are revealing to it (Brecht 108).

Galileo envisions the act of translation or revelation as a way of helping the human race “develop its own powers” through a truly collaborative act. In true Brechtian socialist fashion, the emphasis remains not on the scientist as an intellectual elite, but on the commoner using her newfound knowledge in an effort to enact social change. Having understood the need for scientific understanding and technology in the eventual revolution, Galileo can finally recognize that scientists must work in

concert with the common people for change, that the struggle cannot be theirs alone. He posits, too, that an engagement with the world is critical to responsible scientific conduct: "But can we deny ourselves to the crowd and still remain scientists?" he asks (Brecht 108). Galileo's failure, as understood by the audience, is that, by capitulating to the Inquisition and recanting, he denied not only himself but also his science to the "crowd," effectively silencing the wave of doubt that surged in his wake.

The elusive nature of Galileo's betrayal

In an idealized Brechtian reading, the ideological clash between Andrea and Galileo in the play's later scenes would be viewed impartially, as a matter of dialectic, not emotion. Andrea's emotional connection with his mentor, however, means that he proves unwilling to condemn him, even as Galileo is actively demanding it. Similarly, the dramatic weight of the play, which has been so strongly invested in the sustained didactic relationship between Galileo and Andrea, refuses to succumb to the weight of the text. In short, we resist Galileo's self-accusation of horrific cowardice and betrayal because from our limited perspective he has been engaged in an act of translation from the beginning, an act that even his climactic renunciation cannot undo. His teaching provides a space for the audience to remain critically engaged in the dialectic, allowing us to learn as Andrea and the other characters who act as Galileo's "students" do.

Galileo remains true to his vocation as a teacher almost throughout the play. While Andrea is his most consistent project, he also cultivates a wide circle of assistants whom he engages in the scientific project, from Federzoni¹⁴ to the Little Monk¹⁵ to his friend Sagredo. As the rational, pragmatic doubter, Sagredo is instrumental in allowing Galileo to explain his theories of empiricism. Scenes 3 and 4 of *Life of Galileo* follow Galileo through his claims for the power of the visual proof. First, Galileo attempts to convince Sagredo, his closest friend, of what he has seen. Sagredo does not disbelieve him, but shies away in horror from the religio-political implications of the evidence of his eyes.

GALILEO: Exactly. And that's what we can see. Keep your eyes glued to the telescope, Sagredo, my friend. What you're seeing is the fact that there is no difference between heaven and earth. Today is 10 January 1610. Today mankind can write in its diary: Got rid of Heaven.

SAGREDO: That's frightful (24).

For Galileo, here, the act of seeing becomes the act of knowing the truth. Within that truth, there is no room for ideological compromise. Sagredo demands of Galileo, "Where is God?" Galileo retorts:

¹⁴ Federzoni, described in the character notes as "a lens grinder, Galileo's assistant," also straddles the science/layman divide. He has a consistent interest and engagement in Galileo's experiments; in all respects, his is a scientific mind, but he cannot join the scientific elite because he is uneducated and does not speak Latin.

¹⁵ The Little Monk, for example, dramatically reverses his ideology, from a deeply orthodox believer in the church's teachings to a follower of Galileo's new science. Since he is a scientist from the very beginning, Galileo's role is very different for him: instead of translating science for him, or even offering him the proof of his eyes, Galileo must only feed the seeds of doubt within the Little Monk's brain. He needs only to convince the Monk to accept what he already knows to be true.

GALILEO *angrily*: Not there, anyway. Any more than he'd be here on earth, suppose there were creatures out there wanting to come and look for him. (...) Within ourselves or nowhere (28).

Sagredo, however, recognizes that Galileo's insistence on the truth is untenable; that the human connection to religious tradition is stronger than Galileo gives it credit for. Sagredo insists that human beings are not open to reason alone, whereas Galileo insists that if a boy can be convinced to put on a hat when it is raining, then people can accept proof.

Galileo continues to insist on the power of visual proof, which he posits as a panacea against doubt for those from all walks of life. He claims that mere sight of the truth will be convincing:

GALILEO: I'll take them by the scruff of the neck and I'll drag them to the telescope. Even monks are human beings, Sagredo. Even they are subject to the seduction of proof. Copernicus, don't forget, wanted them to believe his figures; but I only want them to believe their eyes (Brecht 32).

Initially, Galileo speaks of people wanting to see for themselves, but he also locates that desire as springing spontaneously from a more generalized curiosity in the state of the world, a curiosity endemic of changing times, beginning with the uneducated classes. In his conversations with Sagredo and Andrea, however, he demonstrates a willingness to initiate understanding that seems at odds with both his first and last position speeches. He says that he will "take them by the scruff of the neck and ... drag them to the telescope," an aggressive assertion that is backed

up by his later scenes with the philosophers of the Medici court. This threat contrasts with the final claims Galileo makes about the common people, who “tore” the telescope from the scientist and “trained it on their tormentors.” The contrast being drawn seems to be between those who are willing to see, who will actively engage with scientific doubt and proof, and those who choose not to believe the proof of their eyes, who must be forced to know the truth.

But then Galileo’s interactions with the court of Medici also show the limits of his acts of translation. The philosopher who accompanies Cosimo de Medici to see Galileo’s “famous tube” inquires:

PHILOSOPHER: Mr. Galileo, before turning to your famous tube, I wonder if we might have the pleasure of a disputation? Its subject to be: Can such planets exist?

MATHEMATICIAN: A formal dispute.

GALILEO: I was thinking you could just look through the telescope and convince yourselves? (Brecht 38)

Galileo’s polite plea, iterated throughout the scene, goes unanswered as the academic orthodoxy – from whose ranks Galileo is clearly excluded – uses the tactics of debate to silence Galileo’s calls for ocular proof in favor of maintaining the status quo. Their power as thinkers is dependent on the continuing superiority of the Aristotelian system, which the Church adopts, rejecting proof for what Galileo would formulate as unthinking faith that continues to oppress the poor and disenfranchised at a significant remove from the philosophers who stand around in Galileo’s workroom and ask “are such stars necessary?” (Brecht 39)

The philosophers' response to Galileo is strongly based on their desire to maintain the theological beliefs of the Church as a way of making sense of their place in the universe. The more cynical reading suggested by Galileo's speeches instead implies that the philosophers and intellectual elite who are made powerful by their connection to the Roman Catholic Church use the constraints of history and tradition to *protect* that power from a technical revolution that would enfranchise the under classes at the expense of the elite. The potent combination of fear and faith that drives the establishment against Galileo proves a powerful opponent to his scientific reason. Even Barberini, the Cardinal and later Pope, whom Galileo insists is the Church's greatest hope to embrace his empirical method,¹⁶ becomes zealous in his desire to protect the church's interests.

In scenes with the Medici court and at the papal seat in Rome, Brecht frames Galileo as standing essentially alone against the might of the Church: his theories and proofs against centuries of their establishment. It is tempting for the audience to read this frame as an endorsement of Galileo as a hero out of classical theatre, David against the Goliath of the Church. A reading of Galileo as hero is only strengthened by his moments as a teacher and mentor – all of these roles directly call Galileo to the defense of his discoveries, a role he is more than adequate to fulfill. Were *Life of Galileo* a drama in a more classical mode, like Shaw's *Saint Joan*, Galileo's capitulation might be viewed tragically – Galileo might be presented as a fallen hero, not a monster. Brecht, however, stains Galileo's tragedy with the language of betrayal, both in how he frames the character and in his critical writings

¹⁶ GALILEO: Well: so now they need people like Barberini who have read a bit of mathematics! Things are beginning to move (Brecht 76).

around the play, where he refers to Galileo's recantation as "the original sin of modern natural sciences," (Brecht 126) implying that Galileo's historical capitulation to authority doomed following generations of physicists to an amoral and irresponsible conduct of science because of Galileo's willingness to sacrifice principles for physical integrity.¹⁷ With this movement from leader of the revolution to debased and dishonored, Brecht draws a clear path of culpability from Galileo to his contemporary physics – to the atomic bomb, which shaped his later reworkings of the drama to include this condemnation explicitly.

Brecht is unwilling that we read his scientist as a pure hero and his characterization shifts rapidly between zealous ideologue and diffident genius. His constant shifting between ideologies especially affects the act of translation; specifically, the question of who ought to be the recipient of said translation. Galileo is cuttingly cruel to his daughter Virginia when she asks to look through the telescope, dismissing her with the statement "what for? It's not a toy" (Brecht 31). He is even ruder when it comes to Ludovico, his student and Virginia's fiancé; Ludovico, however, reveals himself to be privileged, bourgeois, and inconsiderate and so it is hard for the audience to feel the sting of his rejection. His treatment of his daughter, however, is much more difficult to parse. Brecht doesn't frame their interactions so as to make Galileo's rejection of Virginia seem deserved, or even considered; in fact, he barely frames them at all. Galileo's interactions with his daughter are presented as afterthoughts or transitional: they occur on the margins

¹⁷ Brecht's quote illustrates his mutable and occasionally problematic relationship to historical fact: while he clearly edited and at times even created his pseudohistorical record from whole cloth, he just as frequently maintained that his play was, if not a direct transcript of historical events, then certainly true in tenor.

of scenes with much more substantial dialectics and his dismissals of Virginia feel like nothing so much as afterthoughts. Without centering on Virginia's fearful criticisms of Galileo's science (which are far too simplistic to be properly described as dialectics) or his calculated way of erasing his daughter's concerns, the audience can only read their interactions as a way of further complicating his character.

The nail in the coffin of tragic hero comes with the scene of Galileo's recantation – a scene that is notable for the way that it removes his voice altogether. Brecht resists dramatizing the moment of Galileo's interrogation and capitulation. Instead, he frames Scene 13 around Andrea, the Little Monk and Federzoni, as they wait for news of Galileo's fate. Brecht even takes the words of Galileo's recantation out of his mouth and gives them to an anonymous town crier. By centering on Andrea and the other scientists whom he has betrayed, Brecht deprives Galileo of his moment of tragic downfall; it is this scene, more than any other, which sets up the parameters of Galileo as fundamentally un-heroic.

Following Brecht's treatment of Galileo through iterations of *Life of Galileo* and his extra-dramatic criticisms of the character, the reader/audience can create a genealogy of scientific culpability. He addresses Galileo's specific wrongness but in doing so elevates the scientist's role beyond that of a mere mortal. In his essay "Brecht's Epic Theater: Theory and Practice," W. A. J. Steer maintains that Brecht's praxis – his final characterization of Galileo – doesn't fit with his epic theory:

The play's ending remains curiously unsatisfactory because Brecht, in demanding that his hero should sacrifice himself for an ideal cause (albeit the cause of social revolution itself), has violated the

principle of epic theater and raised a claim that his vision does not and cannot encompass.¹⁸

Steer identifies the ending of *Life of Galileo* as a disappointment because, as he says, "Brecht's theater is committed to the restoration of the individual, not to his annihilation, even for the best of causes." (Steer 648). In sum, he makes the case that Brecht's epic theory does not discount persons even in campaigning for the people and stresses the importance of the individual in Brecht's theory. Brecht's requirement for moral conduct, that Galileo be willing to be annihilated by the Inquisition or to annihilate himself in shame, would make Galileo something more than a human actor, whereas throughout the play, he is presented as intensely, uncompromisingly human. His characterization is marked by physicality and pleasure in material delights. In "Three Notes on the Character of Galileo," Brecht says, "My Galileo is a powerful physicist with a tummy on him, a face like Socrates, a vociferous, full-blooded man with a sense of humour, the new type of physicist, early, a great teacher." His sensual aspect is bound up with his intellectual pursuits:

He insists on his physical pleasures because of his materialist convictions... the point is that he *works* in a sensual way... for instant, the 'beauty' of an experiment, the little theatrical performance with which he gives shape to each of his lessons.
(Brecht 120)

That sensual pleasure in discovery, teaching, and learning is evident in the way he demonstrates physics to Andrea, actually moving Andrea about the room as he

¹⁸ Steer, W.A.J. "Brecht's Epic Theatre: Theory and Practice." *The Modern Language Review*, Vol. 63, No. 3 (1968): pp 636-649. JSTOR. Web. December 2009.

demonstrates the motion of the earth around the sun. It is when Galileo is more human, not less, that he more fully embodies the role of engaged scientist that Brecht demands when he has Galileo cry, “Can we deny ourselves to the crowd and still remain scientists?”

There is tension between the ultimate self-sacrifice implicitly demanded by Brecht in Galileo’s final scenes and the materialistic humanity so central to Galileo’s teaching. Brecht localizes this tension with Galileo’s movement from scientific researcher to figurehead for intellectual and scientific freedom as its translator to betrayer of the freedom and finally once again to researcher. Brecht’s framing of Galileo’s final speech posits that as the translator, Galileo would have had the opportunity to transcend the role of potentially thwarted scientist to become some sort of intellectual messianic figure who leads the people to greater enlightenment – at least, that is the implication. By the time he speaks to Andrea again, Galileo has become convinced that he once held enough power in the people’s minds to have resisted the Church unscathed: “For a few years,” he says, “I was as strong as the authorities” (Brecht 109). To this, Andrea can mount no response except to say, “I cannot think your devastating analysis will be the last word” (Brecht 109) and yet, it is, for after this speech the audience leaves Galileo for good, to continue with Andrea for one more scene as he smuggles the *Discorsi* out of Italy.

This final scene holds the promise of some redemption for Galileo, as it enacts the final realization of his goals – Andrea takes the *Discorsi* out of Italy, to distribute it throughout Europe. Even for this to happen, however, Galileo must give up any stake he has in the translation or transmission of his oeuvre: its fate is

entirely in Andrea's hands, while he remains trapped under house arrest. The last irony of the Galileo character is that he ends the play enlightened but impotent.

Brecht creates a series of tensions and dialectics within the character of Galileo, but gives the audience no guidance on how to resolve that tension. Just as the play assumes aspects of many different genres – history play, epic, science play, tragedy – so too the character of Galileo defies easy categorization. This transformative quality makes it difficult to read the character definitely; his position is continually changing. Yet what truly hinders interpretation is not so much the contradictory facets of his characterization but the extent to which the character is centered on stage. Galileo's recantation and the mummer's carnival are truly the only scenes that de-center Galileo's voice. Even at the carnival, moreover, the mythic specter of Galileo presides over the festivities, giving the revelers license to do "just as they please" (Brecht 84). The audience is not permitted similar interpretive freedom. While Galileo's strength as a character permits him to maintain a dialectic that engages the audience in the dramatic project, that same strength and certainty limit the audience's responses to the drama and keeps us perpetually without interpretive agency.

Chapter 2

“The final core of uncertainty at the heart of us all”: Translation, metaphors, and the audience’s role in Michael Frayn’s *Copenhagen*

With regards to the thematic intersection of physical science and society, Michael Frayn’s *Copenhagen* picks up where *Life of Galileo* left off, using similar lenses of translation and interpretive uncertainty to examine a very different milieu. The social concerns of both plays are broadly informed by the historical and scientific moment of the first half of the 20th century. Although *Life of Galileo* takes the form of an historical play, set in the 17th century, Brecht’s last revision, as we have seen, draws its cynicism about science and scientists that permeates Galileo’s final speech from Brecht’s horror at the atomic attacks on Japan, which officially ended the Second World War. Brecht’s contemporary threat of nuclear war underscores Galileo’s calls for a moral practice of science.

The Cold War period spawned many plays that wrestled with the realities and potential dangers of the new atomic physics and of the scientists who studied it. Some plays, like Friedrich Durrenmatt’s *The Physicists*, take a satirical bent, choosing to avoid any real investigation into the sciences, preferring instead to condemn their discoveries all together. Others take a more historical approach: Heiner Kipphart’s *In the Matter of J. Robert Oppenheimer*, for instance, dramatizes the hearings about Oppenheimer’s role in the development of the atomic bomb. Much of its text is taken verbatim from the proceedings of the United States Atomic Energy Commission in 1954, before which Oppenheimer was summoned to testify. While both of these plays address the consequences of scientific conduct, they do so at a remove: *The*

Physicists contains nothing technical at all, and frames its scientific characters as mad from the very beginning, throwing their authority immediately into question; *In the Matter of J. Robert Oppenheimer* grapples with its titular character's moral responsibility through the lens of his security hearings, wherein he had been required to assume responsibility for the entire Manhattan project.

Copenhagen, by contrast, deals explicitly with its science. One of the major critical questions surrounding *Copenhagen* is posed, implicitly, by Carl Djerassi in his review of Kristen Shepherd-Barr's text *Science on Stage*, "When is 'Science on Stage' really science?"¹⁹ Shepherd-Barr attempts a critical overview of the science play as a genre, cataloguing similar thematic trends across plays about science. Djerassi, however, probes the space between being a science play and a play that simply uses science as a plot device – he presents Tom Stoppard's *Hapgood* as an example of the latter, since it uses Heisenberg's uncertainty as a rhetorical device that is, at its heart, philosophical and not scientific. His reading of *Life of Galileo* places more emphasis on the play's social message while failing to acknowledge that social and scientific are two sides of the same coin. Or, perhaps, as he conceives of it, the problem with *Life of Galileo* as a science play is that it doesn't contain enough actual scientific language, process or thought to adequately support its claims to knowledge of the problem with science, so conceptualized. By this token, *Copenhagen* becomes the response, not only to the problem of a science-social play that fails to engage those affected by its message (namely, the audience), but also to the problem of the science-social play in general. *Copenhagen* creates a science play

¹⁹ Djerassi, Carl. "When is 'Science on Stage' Really Science?" *American Theater*, Vol. 24: January 2007. pp. 96-103. Print.

in which physics in general and Uncertainty in particular are integral parts of both dramatic form and hermeneutic function.

Copenhagen treats a specific historical moment; however, it still divorces the on-stage action from historical context. Frayn's play, whose main characters are the legendary physicists Werner Heisenberg and Niels Bohr, as well as his wife Margrethe, addresses the atomic bomb more directly, but still uses the distancing effects of history: instead of depicting events as they unfold, the play is structured so that the long-dead characters revisit their past. Bohr and Heisenberg, both giants in the nascent field of theoretical physics before World War Two, found themselves on opposite sides during the war: Heisenberg remained in Germany to help his countrymen, while Bohr eventually joined the Americans in the creation of the atomic bomb. The play is structured by the scientists' hypothetical attempts many years after their historical collaboration has ended to unravel the truth of their infamous meeting in 1941.²⁰ This framing device allows the characters the dramatic space to reflect on their actions, rather than being bound by the constraints of a plot-driven structure. Frayn has referred to his *Copenhagen* project as being an effort to explore the "epistemology of intention," a project which is explicitly undertaken by the characters, as well as the audience; in fact, the characters act as guides for the audience and reader, their dialogue both creating and interrogating the past.²¹

²⁰ Staging the play as a retrospective on the past frees him from some of the constraints of the historical record, allowing him to advance several different hypotheses for potential meetings.

²¹ Shepherd-Barr, Kirsten. *Science on Stage*. Princeton Univ Pr, 2006. Print.

This heuristic method of interacting with the historical moment mimics, in some ways, Galileo's first and last speeches and his dialectical interactions with other characters, devices of epic theater that allow the characters to reflect on the ideological implications of their actions. A marked difference between the two plays, unsurprisingly, is *Copenhagen's* theme of uncertainty. While the Galilean characters might heatedly debate their positions for the audience's intellectual gaze, surety marks their characterization. Though Galileo might admit that he has been wrong about the role of science in his final speech, he nevertheless finishes the play convinced of his own intellectual authority at the last: his moments of doubt have taken place off-stage, in the years of his house arrest; at the end, he may be humbled but not necessarily wrong. The certainty with which Galileo reflects on his scientific shortcomings bolsters his position as a teacher, but also limits the audience's or even other character's responses. Although *Life of Galileo* is structured roughly as a series of ideological dialogues between characters, Galileo's pride and certainty overwhelm the doubts of his companions; his weight as a character rather fills the stage. Though the audience is privy to Galileo's triumphs and his downfalls, they are prevented from engaging intellectually with the action on stage during the performance; we are constantly reminded of our position as audience, not agent.

In contrast to *Life of Galileo*, *Copenhagen's* byword is uncertainty, a thematic trend that encompasses not only the audience but also the characters that speak, first and foremost, from a position of not knowing. By working within the thematic limits of uncertainty, *Copenhagen* can encompass some of the questions that are raised by *Life of Galileo* but never explicitly acknowledged. Where Galileo raises the

question of scientific translation intersecting with a moral practice of science as a hypothetical ideal that he has betrayed, Frayn's characters attempt, in their many iterations of the truth, to stumble towards a kind of working model of the scientist's responsibility for translation and its moral implications, a model that proves to depend not on a messianic figure of scientific righteousness but rather on an act of understanding and translation by the audience.

From historical to scientific context

By its very nature, the atomic physics that concern Heisenberg and Bohr resist the empiricism that Galileo initially demands: his telescope might have helped even a dockworker "see" the moons of Jupiter for himself, but the movement of atoms can never be properly visualized. From its beginning, therefore, Frayn's play takes as given Brecht's final assertion – that science needs a translator in order to be understood by the masses – while simultaneously interrogating whether the science must be understood in order to engage with the thematic movements of the play. In *Life of Galileo*, some understanding of Galileo's astronomy and science were necessary – mediated through Andrea – in order for the viewer to understand the implications of his discoveries. Just as important, however, is knowledge of Galileo's cultural climate, as his specific struggle, although not Brecht's wider concerns, is strongly informed by his historical moment. Frayn replaces *Life of Galileo's* unique historical moment with a different historical context, one that typifies a new kind of physics; this new physics requires a new practice of science, one that is more

comfortable with an ontological uncertainty.²² The Uncertainty Principle as discovered by Heisenberg, one of the play's three central characters, acts at times as a scientific metonymy for the new and unbounded field of theoretical and quantum physics that occupied both Bohr and Heisenberg.²³ Bohr is described as "the first of us all, the father of us all. Modern atomic physics began when Bohr realized that quantum theory applied to matter as well to energy. 1913. Everything we did was based on that great insight of his" (Frayn 5).²⁴ If Bohr is the father, it is Heisenberg who is the wayward son, who discovers without ever working through the implications of his work; his mind is largely mathematical, not social. The characters also use the Uncertainty Principle to metaphorize their inability to understand the past: as they experienced the past, they cannot understand their motivations; they know where they are (or were) but not why they are.

²² The complexity and nuance of quantum physics of course far outstrips that of the science presented in *Life of Galileo*. Since the solar-centric planetary system model has now been proven empirically correct for centuries and is taught in primary schools, most audience members could reasonably be expected to understand the science that is presented to them. When Heisenberg says that "everyone understands uncertainty," it is clear that he is restricting the bounds of his "everyone" to the scientific community, not to the audience at large – something that Heisenberg does frequently, given his resistance to the "plain language" that Bohr insists upon.

²³ Frayn explains the uncertainty theorem thus:

Heisenberg I show him the strangest truth about the universe that any of us has stumbled on since relativity -- that you can never know everything about the whereabouts of a particle, or anything else, even Bohr now, as he prowls up and down the room in that maddening way of his, because we can't observe it without introducing some new element into the situation, a molecule of water vapour for it to hit, or a piece of light– things which have an energy of their own and which therefore have an effect on what they hit (Frayn 70).

²⁴ Frayn, Michael. *Copenhagen*. New York: Anchor Books. 1998. Print.

Frayn's use of quantum physics as a thematic element of the play places extra importance on the act of translation to the audience. Early in the play, Heisenberg asserts:

Heisenberg Now we're all dead and gone, yes, and there are only two things the world remembers about me. One is the uncertainty principle, and the other is my mysterious visit to Niels Bohr in Copenhagen in 1941. Everyone understands uncertainty. Or thinks he does. No one understands my trip to Copenhagen (Frayn 4).

From the beginning, an equivalence is established between the Uncertainty Principle and the Bohr-Heisenberg meeting of 1941; the characters cast themselves as experimenters on their own lives, attempting to interrogate the events of the past in the same way that they revealed the uncertainty relationship. The result, however, is cyclical, not progressive: by viewing their interactions through the language of uncertainty, the characters only become less sure. This cyclical structure creates a critical role for the audience in Frayn's work different from their role as audiences of Brecht's: the audience and reader must act as kinds of scientist themselves, interpreting the intentions and motivations of the on-stage actors like the results of an experiment, rather than responding to the characters' dialectical positions. This need, however, underscores how crucial it is that the audience understands the science of uncertainty, without which knowledge, the characters' motivations are obscure. The theoretical and nuclear physics of *Copenhagen* are far more removed than Galileo's astronomy, placing an extra onus on the scientist characters to be effective translators; if the audience does not understand the

science, they will be less likely to engage critically with the social dimensions of the work. Additionally, Bohr and Heisenberg's characters are most carefully illuminated by their approaches to scientific discovery and exploration. The staging of the play's most explicit concern – probing the events of Copenhagen 1941 – directly and necessarily invokes the language of quantum physics, the Uncertainty Principle, and wave-particle duality; an understanding of these discoveries is essential in order to comprehend the implications of their Gedanken (thought experiments).

Scientific humanism and the multifaceted role of translation

The act of translation is key to understanding the metaphoric and visual imagery that the characters use to describe their motivations throughout *Copenhagen*. As the scientist who originates the motif of “plain language” that echoes throughout the play, Bohr takes the lead role in initiating translation, a position which gives him a unique position of authority with relation to the audience relative to the other characters on stage. He acts as a mentor and pseudo-father figure to Heisenberg despite Margrethe's strenuous objections. This authority within the drama carries over into the audience: in accepting Bohr's metaphors as true, we give him a certain interpretive authority. Transitively, we begin to prefer Bohr as a character because of the way that he insists on translation. This act of translation becomes an effective way of providing information to the audience, as well, although it is clear that for Bohr, at least, such a translation involves primarily Margrethe:

Bohr Only Margrethe. We're going to make the whole thing clear to Margrethe. You know how strongly I believe that we don't do science for ourselves, we do it so that we can explain it to others...

Heisenberg In plain language...

Bohr In plain language. Not your view, I know – you'd be happy to describe what you were up to purely in differential equations if you could – but for Margrethe's sake...

Heisenberg Plain language. (Frayn 38)

In this quotation, the inclusion of Margrethe implies the exclusion of the hypothetical rest of the nonscientific community within the world of Bohr and Heisenberg's physics; this move clearly echoes of Galileo's inclusion of Andrea to the exclusion of other community members. On this stage, in this space, however, there are no other characters to be excluded; Bohr's special mention of Margrethe seems more like a gesture of respect to her than a rejection of other non-scientists, an acknowledgment that she is the only non-scientific character close enough to the characters to be the recipient of their scientific wisdom.

Margrethe would seem the optimal character to serve as a vehicle through which science is translated for the audience. Like Andrea, she occupies a space at the intersection of the scientific and non-scientific communities. Unlike Andrea, however, she is never fully integrated into the scientific community. Her relationship to science is entirely mediated through her husband, Bohr and she is

frequently excluded²⁵ from key moments of Bohr and Heisenberg's interactions, particularly their moments of actual scientific discovery, whereas Andrea becomes a key figure in Galileo's team of scientists. Rather than limiting her as the audience mediator on stage, however, her condition of existing at a constant remove from the other characters on stage serves to align her more with the audience.

She is able to mimic their language, to use their imagery, and thus provides the key link between Bohr and Heisenberg as the originators of knowledge and the audience as its final receiver. Bohr explains to her and she then uses that knowledge as a translator herself, for those in a position of even less information than she. She places herself in the position of interpreter in both scientific and non-scientific contexts, a role that addresses the minimalist nature of Frayn's set and stage directions. As the actors move about the stage, Margrethe's narration provides context for their actions, both historical and emotional:

Margrethe It's like the worst moments of 1927 all over again, when Niels came back from Norway and first read Heisenberg's uncertainty paper. Something they both seemed to have forgotten about earlier in the evening, though I hadn't. Perhaps they've both suddenly remembered that time. Only from the look on their faces something even worse has happened. (Frayn 32)

Here, Margrethe acts as a part of an extra-dramatic text, providing – at the same moment as Bohr and Heisenberg interact – an interpretation of their actions. The playbook of *Copenhagen* provides no extra-dialogic cues and so, for the reader and

²⁵ This exclusion exists only within the character's histories, rather than during the on-stage moments, but is felt keenly by Margot and oft-referenced.

indeed, the actor, Margrethe's narration is essential as a way to connect to the characters, a task which is frequently intertwined with using scientific language; at the same time, however, the narration also takes the form of observation, which is inherently distancing. Like so much in *Copenhagen*, she can occupy both spaces at once: she connects, yet distances; she is a particle, she is also a wave. Through her observation, Margrethe is able to engage in moments of scientific dialogue:

Margrethe Something about fission?

Bohr What happens in fission? You fire a neutron at a uranium nucleus, it splits, and it releases energy.

Margrethe A huge amount of energy. Yes?

Bohr About enough to move a speck of dust. But it also releases two or three more neutrons. Each of which has the chance of splitting another nucleus... (Frayn 33)

This discussion, which gives context for one of many disagreements between Bohr and Heisenberg, also educates the audience about nuclear fission. Although Margrethe is able to take place in the conversation, she doesn't hold any intellectual power: she is as likely to misuse scientific concepts as to choose an appropriate metaphor. Her exchange with Bohr is dependant on his validation of her presence in the conversation and his correction of her misapprehension. Despite her unique position with relation to Bohr and Heisenberg's science, Margrethe never manages, as Andrea did, to cross spheres into the scientific. Her removal from scientific investigation might render her a closer analogue to Galileo's daughter Virginia than to Andrea, leaving a hermeneutic space for Heisenberg to be read as a version of

Andrea and Bohr, the consummate teacher and mentor, to assume the position of Galileo. Virginia, however, was actively discouraged from engaging in her father's scientific project, portrayed as a silly and superstitious girl. Both Bohr and Heisenberg treat Margrethe with gravitas, and her concerns, though they are emotional more than scientific, are given equal weight to Heisenberg and Bohr's.

Although she provides a bridge between the on-stage scientists and the lay audience, the precise act of translation on the stage must begin with Bohr and Heisenberg. Frayn probes the connection between a scientist's willingness to engage in translation and the moral practice of science. For Frayn, this is a complicated duality. The "social" elements of his characters' science are complicated by war: Galileo hopes his science might lead to a yet-distant and hypothetical revolution; Bohr and Heisenberg's individual decisions to weaponize nuclear energy are prompted by fear, death, and a kind of twisted patriotism. Frayn establishes multiple reasons for his characters to engage in acts of scientific translation, some of which are noble, some selfish, and some morally reprehensible.

From the beginning, Frayn equates a willingness to translate with didacticism, like Brecht, but also recognizes the more "selfish" implications of translation: Bohr's willingness to engage in translation also has bearing on his own practice of science. Frayn's play is concerned explicitly with this practice – how experiments are structured, how they are interpreted. Bohr is described as meticulously careful, concerned with repeating experiments, wanting to be *sure*. Heisenberg contrasts Bohr's scientific method with his own, which places its greatest stock in numbers:

Heisenberg Something you're always accusing me of. 'If it works it works.'

Never mind what it means.

Bohr Of course I mind what it means.

Heisenberg What it means in language.

Bohr In plain language, yes.

Heisenberg What something means is what it means in mathematics.

Bohr You think that so long as the mathematics works out, the sense doesn't matter.

Heisenberg Mathematics *is* sense! That's what sense is.

Bohr But in the end, in the end, remember, we have to be able to explain it all to Margrethe (Frayn 66-67).

The question here is semiotic: what does it mean to mean? Bohr is concerned with the implications of his physics in the physical world, a view that has pragmatic echoes, whereas Heisenberg's concerns rest with the internal consistency of mathematics. Heisenberg trusts in whole numbers, complete unto themselves, as signifiers of sense; his translation runs from theory to mathematical explanation, without progressing further into the realm of layman's understanding. His cyclical focus – numbers mean only what they signify numerically – serves to distance Heisenberg from the wider implications of his actions and, furthermore, from the non-scientific community.²⁶ This reading of Heisenberg's character makes it easy for

²⁶ Frayn creates a strained relationship between Heisenberg and Margrethe. Her resentment of him is multifaceted and far ranging. Part of it is personal: she finds his monopoly over her husband's time alienating. Unlike Bohr, too, she is unable to subsume her dislike of his politics for the sake of her husband. As David Voss says in his review of the Michael Blakemore production: "Through Margrethe, the play

the audience to align itself purely with Bohr and the historical condemnation of Heisenberg as a traitor to the larger ideals of Science because he aligned himself with Germany and the Nazi Party. Frayn's character is not so simply drawn, however. The lens of uncertainty through which the characters read their 1941 meeting can also be applied to Heisenberg: his motivations can constantly be re-examined based on the context of his words. In the end, it is the audience, not the playwright nor his fellow actors, who are responsible for truly allocating judgment of his character.

Initially, Heisenberg's relationship to the world of "reality" is restricted to application. When a moral dimension is introduced to his investigations, he is reliant on Bohr's mentorship to guide him. The conflict between himself and Bohr remains somewhat vague, but his concern with the viability of nuclear fission remains constant. This question and Bohr's response is iterated throughout their meetings, with the opening always the same:

Heisenberg There's no mystery about it. There never was any mystery. I remember it absolutely clearly, because my life was at stake and I chose my words very carefully. I simply asked you if as a physicist one had the moral right to work on the practical application of atomic energy. (36)

Like a child returning to his father, Heisenberg is reliant on Bohr's humanistic interpretations of his actions for guidance: he needs Bohr's willingness to translate science into a vernacular in order to wrestle with the consequences of his actions.

As befits his implicit position as scientific leader on stage, it is Bohr who is able to

continually reminds us which side Heisenberg was on." (Voss 278) Margrethe refuses to dismiss social concerns in favor of the draw of science and numbers.

recognize Heisenberg's mistakes, once again establishing the act of metaphor, or willingness to interpret, as a way to "discover meanings" beyond formulae and mathematics. Heisenberg's inability to translate science or to metaphorize numbers also becomes his specifically scientific downfall. He puts faith in numbers to the extent that he doesn't even think to check his math and becomes endangered by the very science he once trusted beyond everything else – it develops that not only did he have the capacity to manufacture nuclear weapons within his grasp, but that the German reactor he was in charge of could easily have gone critical and killed him. Frayn also allows the audience to read a stronger irony into Heisenberg's mistake – that Heisenberg's *arrogance* with regards to his numbers is what leads to his downfall; rather than putting faith in numbers, he locates all that faith within his own abilities, which sometimes prove lacking. Frayn draws on these moments with complex poignancy, which leaves Heisenberg's fault unclear.

In Heisenberg's case, his motives remain sufficiently elusive to allow for a potentially nuanced or sympathetic reading of the character. All of the characters are operating in a realm of motivation that is half-remembered, half-fabricated from the remembrances of the other characters on stage. There is no empirical standard of truth to which the characters can compare themselves; even the metaphors of quantum physics that they use to visualize their behavior cannot be precisely understood. When Heisenberg interprets Heisenberg's actions, it is with a sense of his noble intentions, positioning him as a tragic hero, a victim of circumstance.

Both August Staub²⁷ and David Klemm²⁸ draw connections between scientific practice and humanism in *Copenhagen*. Staub positions both scientists, but Heisenberg in particular, as a kind of agonized Byronic hero:

But now science is truly a metaphor for human life, or – as the playwright Michael Frayn and others are now confounding the two – the state of being human and the scientific method have now become inseparable so that great scientists like great poets can suffer as Byronic heroes trapped in their own human condition (Staub, 133).

In this reading, Heisenberg struggles away from “passionate puritan”²⁹ science towards humanism, which “put[s] the human at the center of the universe where man is the measure (and measurer) of all things” (Staub, 135). In Heisenberg’s case, he must weigh his love for his country and memory of its past poverties and humiliations against the existential horror of the bomb. By depicting it as a struggle, Frayn offers Heisenberg redemption from historical realities. No longer merely the Nazi scientist, Heisenberg is a man conflicted between his country and his loyalties outside of science.

The structure of his struggle, however, as presented by Frayn, can invoke no clear response from the audience. Each character is seen only through the lens of

²⁷ Staub, August. "The Scientist as Byronic Hero: Michael Frayn's *Copenhagen*." *Journal of Dramatic Theory and Criticism*. Google Scholar. [Online]: December 2009

²⁸ Klemm, David. "'The Darkness Inside the Human Soul': Uncertainty in Theological Humanism and Michael Frayn's Play *Copenhagen*". *Literature & Theology*; Vol. 18, No. 3 Sept. 2004: 292 – 307. Online: December 2009

²⁹ Staub's own formulation of the dichotomy that I note between science for science's sake and science for society.

their own perception or their fellow characters: without the constraints of the historical record, Frayn couples interpretation to perception, not absolute truth. The audience's interpretation of the characters based on their approaches to science – preferring Bohr's plain language approach to Heisenberg's fondness for abstractions and number – is complicated when presented with Bohr and Heisenberg as men with lives and concerns outside of their science, particularly as those who have suffered during the war. To expand the metaphor of uncertainty, both characters exhibit wave-particle duality of personality, able to be viewed by each other or the audience either as scientists or civilians, depending on context. Even this new complexity is nuanced, however: since Heisenberg and Bohr had been separated since before the outbreak of WWII, only the character's readings of themselves, as naturally biased as they might be, can aid in our understanding.

Heisenberg, whose preference for mathematics veers dangerously close to emotional frigidity, asserts that he is much more aware of the ravages of war than Bohr: as a citizen of Germany, Heisenberg was forced to live through both world wars and their attendant bombings, slaughter and starvation. Heisenberg suggests that Bohr's willingness to endorse the atomic bomb for the Allies, while condemning Heisenberg's own involvement with the German nuclear program, stems from his unwillingness to admit moral gray areas of any kind, a refusal that lies with his relative ignorance of the realities of war:

Bohr My dear, good Heisenberg, we weren't supplying the bomb to Hitler!

Heisenberg You weren't dropping it on Hitler, either. You were dropping it on anyone who was in reach. On old men and women in the street, on mothers and their children. And if you'd produced it in time they would have been my fellow-countrymen. My wife. My children. That was the intention. Yes?

Bohr That was the intention.

Heisenberg You never had the slightest conception of what happens what bombs are dropped on cities. Even conventional bombs. None of you ever experienced it. Not a single one of you (43).

Bohr's unwillingness to engage with the complexities of the bomb significantly complicates our reading of his moral authority. While he is able to articulate disgust at Heisenberg aligning himself with Hitler, he seems to have less conception of the actual physical cost and realities of war. Heisenberg, who lived through WWI and WWII in Germany, is the character who has the most experience of war's ravages.³⁰ In this case, it is Bohr who is constrained by the theory – dropping bombs will hurt Hitler and win the war – and Heisenberg who pushes against that reading by insisting that Bohr confront war's human cost. Where Bohr once appeared to have the moral authority in matters of science, Heisenberg now proves to be the more nuanced in his view of wartime. It is clear that neither Bohr nor Heisenberg can fully

³⁰ Although Bohr never directly contradicts Heisenberg's claim that he did not know the true horrors of war, Copenhagen *was* occupied by German troops during the war but never bombed. Bohr and Margrethe later allude to the event known as the Rescue of the Danish Jews; both Bohr and Heisenberg imply that Heisenberg was in some way responsible for the rescue through his "man" Georg Duckwitz. Like so much of what Heisenberg implies, the truth of this claim is left to the mind of the reader.

and properly embody a humanistic, rather than objectivist, approach towards scientific translation. Heisenberg is unable to allow science to coexist with plain speech, but also has compassion for the sufferings of war. Bohr's position, demanding translation for the audience, initially draws our respect, but is later complicated.

For a time, it seems as though Frayn might aid in the historical condemnation of Heisenberg, which holds him more personally culpable than Bohr in the misuse of atomic energy. Heisenberg pushes against his place in history by subtly implying to Bohr (and the audience) that Bohr, too, has things to feel guilty for:

Heisenberg Fermi says it was you who worked out how to trigger the Nagasaki bomb.

Bohr I put forward an idea.

Margrethe You're not implying that there's anything that *Niels* needs to explain or defend?

Heisenberg No one has ever expected him to explain or defend anything. He's a profoundly good man.

Bohr It's not a question of goodness. I was spared the choice.

Heisenberg Yes, and I was not. So explaining and defending myself was how I spent the last thirty years of my life (47).

Here again, responsibility is associated with an ability to explain. Bohr seems to be absolved – considered a “profoundly good man,” defended explicitly by Margrethe and implicitly by his physics colleagues – and this means that he need not explain his actions. The reader wonders, though, what makes Bohr above reproach; perhaps

it is because he is the acknowledged first among his scientific colleagues, the “pope,” as Heisenberg calls him. This superiority seems to be based on Bohr’s ability to make sense of things. Bohr and Heisenberg remember the “papal progress” that led to an understanding of complementarity – the “Copenhagen Interpretation,” as they call it, significantly – as Bohr’s train journey to transmit explanation and translation to all of his fellow physicists.

Frayn creates certain interpretive parallels between the characters as scientists, in similar positions, though on opposite sides, during the war. Rather than condemn or condone the moral failings or strengths of either, he posits that the difference between a traitor to science and “a profoundly good man,” is not even what choice you make, but being in the position to make a choice at all. These two characters, like the particles they conceptualized, embody a wave-particle duality. This duality is echoed, not only in their behavior, but also in their relationships to each other. As Heisenberg remarks: “I’m your enemy; I’m also your friend. I’m a danger to mankind; I’m also your guest. I’m a particle; I’m also a wave.” (77) Their complementarity adds an element of interpretive complexity to both Bohr and Heisenberg. Heisenberg can comment on Bohr’s ambivalent feelings towards him, while Bohr and Margrethe offer readings of Heisenberg’s motivations. In Frayn’s formulation, however, the objective truth can only be achieved probabilistically, through a series of estimations, by reflecting one character’s readings of another through the lens of their own interpretive bias. Literalizing the scientific language of theoretical physics through the actions of the characters allows Frayn to use that physics as source for metaphors of human behavior.

Performative metaphors to translate human nature

Formally, *Copenhagen* is a masterpiece of careful construction. Everything from dialogue to performative movement to the set design³¹ cooperates to form a cohesive metaphoric whole. Frayn first establishes Bohr and Heisenberg's interactions with science and language, creates their mode of translation, and then works their methods of interaction into an overarching structural metaphor.

Bohr's and Heisenberg's characters may be illuminated by the way they translate science – or don't – for the laity, but for various reasons, both literal and symbolic, the characters' ability for self-knowledge is limited. In order to suggest more broad thematic points about the nature of truth and knowledge and certainty, Frayn turns to metaphors not only as a means of translating science but which use science to conceptualize human nature. Instead of metaphors *about* science, these metaphors are metaphors *of* science. They can be purely verbal, as with Heisenberg's "I'm a particle; I'm also a wave," but also performative, dependent on the way the actors move around the stage and interact with each other.

Performative metaphors of scientific concepts are key to staging *Copenhagen*, since Frayn does not include any stage directions in his text. Frequently, the characters' dialogue serves to indicate the ways that they are meant to move. Often this occurs with a shift into descriptive present tense when the Bohr and Heisenberg are rehashing their meeting. Suddenly, Heisenberg will begin describing his approach to the house:

³¹The set design from Michael Blakemore's production has become paradigmatic.

Heisenberg Why did I come? And once again I go through that evening in 1941. I crunch over the familiar gravel, and tug at the familiar bell-pull. What's in my head? ...

Bohr I open the door...

Heisenberg And there he is. I see his eyes light up at the sight of me.

Bohr He's smiling his wary schoolboy smile.

Heisenberg And I feel a moment of such consolation... as if I'd come home after a long journey (53-54).

This act of description is similar to a Brechtian alienation device, wherein the actors on stage begin describing their actions in order to create critical distance between the actor and character. In the case of *Copenhagen*, the same device serves to remind the audience that multiple chronologies are being sustained at once. Changing the action to a "re-enactment" scenario also serves to break the pattern of motion established by the characters when they aren't re-enacting, per se, but simply reflecting on those re-enactments. Breaking the monotony highlights the characters' other movements as well, which are based around the elaborate structuring image of an atom. In Act Two, revisiting their shared history of scientific discovery begins to illuminate the atomic motif:

Heisenberg ... Kramers had the private office next to yours, like the electron on the inmost orbit around the nucleus. And he didn't think much of my physics. He insisted you could explain everything about the atom by classical mechanics.

Bohr Well, he was wrong.

Margrethe And very soon the private office was vacant.

Bohr And there was another electron on the inmost orbit.

Heisenberg Yes, and for three years we lived inside the atom.

Bohr With other electrons on the outer orbits around us all over Europe (Frayn 58-59).

This image of the atom involves a full component of European physicists, joining them together in a cross-continental search for scientific truth. This initial metaphor establishes several interpretive parameters: Bohr as the scientific nucleus, Heisenberg as his “innermost” electron, a shift chronicled in the above exchange. Through the next “experiment” – that is, iteration of their meeting and events leading up to it – which takes up much of the second act, the image of an atom is refined and specified until it no longer refers to the entire band of nuclear physicists that flourished in Europe between the wars, now scattered by Hitler.³² The removal of the other scientists makes room for Margrethe to participate in the performative metaphor. It is refined to focus purely on the three on-stage characters as an atom in its purest sense – composed purely of nucleus, electron, and photon:

Heisenberg Listen! Copenhagen is an atom. Margrethe is its nucleus.

About right, the scale? Ten thousand to one?

Bohr Yes, yes.

Heisenberg Now, Bohr’s an electron. He’s wandering about the city somewhere in the darkness, no one knows where. He’s here, he’s there, he’s everywhere and nowhere. Up in Faelled Park, down in

³² Perhaps there is an interpretive pun here about the splitting of the atom.

Carlsberg. Passing City Hall, out by the harbor. I'm a photon. A quantum of light. I'm dispatched into the darkness to find Bohr. And I succeed, because I manage to collide with him.... But what's happened? Look – he's been slowed down, he's been deflected! He's no longer doing exactly what he was so maddeningly doing when I walked into him!

Bohr But, Heisenberg, Heisenberg! You also have been deflected! If people can see what's happened to you, to their piece of light, then they can work out what must have happened to me! The trouble is knowing what's happened to you! Because to understand how people see you we have to treat you not just as a particle but as a wave. I have to use the Schrödinger wave function (Frayn 68-69).

The relatively simple atomic staging is complicated with the characters' realization that they are both actors and interpreters in this drama. Heisenberg's Uncertainty Principle states that the act of detecting or observing a subatomic particle changes that particle's path or velocity slightly so that you can never be sure, really sure, what the particle was doing before you came along. Bohr maintains, "if people can see what's happened to you... then they can work out what must have happened to me!" Unfortunately for this elegant solution, there are no "people" the actors can turn to, save those in the audience, for interpretive insight. In *Copenhagen*, the actors are both observer and observed, and this means that they can never be sure about anything:

Margrethe So this man you've put at the centre of the universe – is it you, or is it Heisenberg? ... If it's Heisenberg at the centre of the universe, then the one bit of the universe that he can't see is Heisenberg.

Heisenberg So...

Margrethe So its no good asking him why he came to Copenhagen in 1941. He doesn't know!

Heisenberg I thought for a moment just then I caught a glimpse of it.

Margrethe Then you turned to look.

Heisenberg And away it went.

Margrethe Complementarity again. Yes? (Frayn 72)

In this passage, Margrethe once again contextualizes the behavior of the characters. While Bohr and Heisenberg are able to apply the language and tropes of scientific investigation to their meeting in 1941, Margrethe is essential in providing this scientific language with an emotional frame to which the audience can connect. This time, however, the context that she provides is itself scientific in nature, as it uses the lens of complementarity, a cornerstone of the uncertainty principle, to help both the onstage scientists and the audience with their struggle to comprehend. Frayn has created a dramatic situation where understanding and experimentation are confused; Heisenberg and Bohr, already unsure of the other's motivations, can now hardly understand their own, let alone come to any comforting conclusion or offer any moral guidance.

This elaborate physical metaphor of movement serves a twofold purpose; the metaphor goes both ways. First, equating the movements of human beings to those of electrons and photons and then putting that equation in motion on a stage makes the translation both clearer and more engaging to the audience. Performance, as well as speech, is essential to this didactic goal. In his essay "Semiotic Modalities of the Body in Modern Theater," Wladimir Krysiniski argues that "the body functions as a secondary sign for the verbal logos."³³ He creates a semiotic square that illuminates the relationship that an acting body has with its verbal text. He states:

In textualized theater the text presupposes the performance and vice versa. This obvious remark implies, however, the unilateral dependence of the performance on the text. It is thus necessary to stress the constricting relationships, which govern the implications of the two deixes as well as the double presupposition of the two schemas. (Krysiniski 146)

The staging of *Copenhagen* "diverges from the text," insofar as the text itself gives no specific requirements as to its staging. Nonetheless, it is difficult to imagine *Copenhagen* staged without enacting the metaphor of characters as atomic particles. The highly performative nature of this organizational metaphor works a way of enlightening the audience, and yet it is also dependent on the audience for its interpretation: all the on-stage characters, being implicated in the performance, cannot objectively see outside of their own performance.

³³ Krysiniski, Wladimir and Mikkanen, Raili. "Semiotic Modalities of the Body in Modern Theater" *Poetics Today*, Vol. 2, No. 3, Drama, Theater, Performance: A Semiotic Perspective (Spring, 1981), pp. 141-161

Heisenberg's atom metaphor feeds into the language of uncertainty that permeates *Copenhagen*. The characters are perpetually envisioned as subatomic particles – photons, electrons, and protons. Their movements are neither predictable nor deterministic and cannot be retrieved by historical investigation. No matter how many variations on a shared past the three characters attempt, their investigations remain obscure.

The imagery is not exact; as previously mentioned, the more strongly performative the drama is, the more removed it becomes from strict realism. Creating a direct comparison between Bohr and Heisenberg and photons and electrons does not serve completely to explain their behavior as it fails to acknowledge that each of the characters has agency, that they chose to meet, “chose [their] words very carefully,” as Heisenberg has it. The mystery comes in trying to *understand* that behavior.

Complex relationships between Heisenberg and Bohr make up *Copenhagen's* emotional core. Similarly, it is not through looking at the metaphorical connection between character and subatomic particle that the audience or reader obtains the most insight; rather, it is through examining the characters' relationships to each other through this metaphoric lens. The performative metaphor carries overtones of Brechtian techniques, particularly that of the Gestus: by exploring the atom through mimesis, the characters are themselves illuminated.

Frayn's play includes a kind of alienation, too. His variant, a response to the classical Brechtian alienation, leaves his characters alienated from each other. As Act Two closes, the characters stand on stage, together but separated:

Bohr My dear Heisenberg! My dear friend!

Margrethe Silence. The silence we always in the end return to.

[...]

Heisenberg And over goes the tiller once again.

Bohr So near, so near! So slight a thing!

Margrethe He stands in the doorway, watching me, then he turns his head away...

Heisenberg And once again away he goes, into the dark waters (93).

The characters are together and participating in an act of dialogue and yet the final scene of *Copenhagen* is suffused with a sense of distance. Heisenberg's capitulation to "that final core of uncertainty at the heart of things;" Margrethe's despair for "our ruined and dishonored and beloved world" (96) – this final scene does not drive the audience away from the project but rather includes them in its despair. And yet, the audience can only be included because the translation has, at a critical moment, failed.

The metaphor of uncertainty as established throughout Act One and elaborated through Act Two cannot be maintained through the end in stasis. At some point, Frayn's own Gedanken of metaphors and theory must vie with the demands of a theatrical medium. Frayn opens the play by establishing the project of *Copenhagen* as one that seeks to answer questions about what happened at Bohr and Heisenberg's meeting in 1941. All of his writing surrounding the play suggests that the ideal of an ultimate truth still drives much of the audience response to the

play.³⁴ The need for some kind of resolution occupies the second half of the second act. However, because the characters are both experimenters and experiment, they will never be able to understand their own motivations and, because the audience relies on the characters' "data" in order to draw conclusions, Frayn is forced to allow conclusion. By the last iteration of events, the characters are capable of observing each other, but not themselves. This is particularly applicable to Heisenberg:

Heisenberg Two thousand million people in the world and the one who has to decide their fate is the only one who's always hidden from me (Frayn 89).

Over the second act, *Copenhagen* moves towards an emotional connection between the characters who begin the play defensively or blaming. As the characters move towards understanding each other emotionally, Frayn overturns his metaphor until Heisenberg's moment of understanding comes at a moment of connection:

Margrethe The great collision.

Bohr I stop. He stops...

Margrethe This is how they work.

Heisenberg He gazes at me, horrified.

Margrethe Now at last he knows where he is and what he's doing.

Heisenberg He turns away.

Margrethe And even as the moment of collision begins it's over
(Frayn 90).

³⁴ His postscript and *The Copenhagen Papers*, which were released several years after the play debuted both include writings around the historical questions that the play raises.

The metaphor is turned almost completely on its head – instead of complicating understanding, the collision between the two allows the moment of understanding that has been hinted towards but never made explicit. The entire exchange, however, remains elliptical. At the moment when Heisenberg gains final awareness of his purpose –when the uncertainty relationship has been resolved – the act of translation breaks down. Throughout this exchange, none of the characters explain their horror to the audience. Even as they start to run through calculations, they speak only to each other, in partial sentences. The translation and context that Margrethe always provides – “Now at last he knows where he is and what he’s doing” – does not give the reader answers, but instead directs the interpretation of the scene obscurely.

Margrethe says of this interaction that Bohr’s failure to translate “was the last and greatest act of friendship for Heisenberg that you performed in return. To leave him misunderstood” (Frayn 91). This act of misunderstanding leaves space for the audience to step into the role of interpreter: we are forced to look on and use what has already been explained to us in earlier scenes in order to follow along and reach the same devastating conclusion that Heisenberg apparently reaches.³⁵ The actual nature of this relationship may remain obscure. In the end, Frayn’s play isn’t particularly concerned with conclusively resolving the “did he or didn’t he” aspect of Heisenberg’s history. Nor is it concerned with Brecht’s after-the-fact prescriptivism, his formula for the rosy dawn of science. Although the characters reflect on actions

³⁵ The Blakemore staging underscores the audience’s need to participate in the translation by actually staging some of the audience along with the actors, as noted by David Voss: “part of the audience sits on stage – the observers participating in what is observed.”

from the past, this final realization takes place in the present, in the now, *with* the audience, not simply being told to them. Throughout *Copenhagen*, Frayn has placed his characters as both observers and observed; well, the audience is an observer too, and by the end of the play they are called upon to step into an interpretive space. The play is not structured to provide the audience with *answers*, per se, but the audience is allowed full access to the characters' own uncertainty, rather than, as Brecht does, wave it aside in favor of a politicized certainty that leaves no room for doubt.

Conclusion

Certain in her uncertainty: the Reader as Scientist

Beginning as two very different plays, *Life of Galileo* and *Copenhagen* develop interpretive parallels over the course of their texts, until both culminate with critical scenes that ask the audience to engage, not just with the play, but with the future of science as envisioned by its creator. In both plays, hermeneutic uncertainty rises as the drama runs its course, but must be accounted for by the play's end. Although both plays, as stated, encourage the active role of the scientist as a translator and an educator, and locate this role as part of a moral praxis of science, the role that the audience is intended to play in this praxis is much less clear.

Frayn explicitly invites uncertainty into *Copenhagen's* hermeneutic sphere as part of the subatomic particle imagery with which his play is rife, but also as a valid response to the dramatic presentation. He accepts that the audience may not know how to read Heisenberg – whether to condemn him or praise him – and indeed encourages that ambiguity in the final moments of the second act by once again centering on Heisenberg's experiences during the war, prompting all three characters' ruminations on loss and the ending of things. The emphasis, finally, is not on what Heisenberg came to Copenhagen to find, but what that meeting cost him and Bohr, and even Margrethe: the death, not just of a friendship, but of a moment in time, when the new quantum physics was rife with possibility and potential, not as weapons but as a new system of knowledge, a new way of looking at the world.

The critical Scene 14 in *Life of Galileo* also serves as Galileo's eulogy for his brief moment when the "rosy dawn of science" seemed achievable, its progress not

yet stymied by the Church and Galileo's own betrayal. Despite complicating our reading of Galileo's character with moments of interpretive ambiguity, Brecht marks his final speech with surety. There is no room for audience uncertainty within the realm of Brecht's epic project; although the audience must be critically engaged throughout the performance, the play's message must be clear at the end.

By forgoing uncertainty and doubt, Brecht remains true to his original, dialectical goals. However, this shift away from questions, towards answers, can also be positioned as a movement away from the scientific mind that Brecht, through Galileo, instills in the audience throughout the performance. Galileo says to Andrea that the spread of scientific knowledge aims to turn the world into "doubters" (Brecht 108). The reader's doubt of Galileo's betrayal based on his shifting characterization between selfish, self-centered man and beloved mentor and educator is one of the most scientific interpretive acts in which she engages; resolving that character dialectic might enfranchise the reader as a part of the proletariat, but disenfranchises her as a scientist.

Copenhagen, by contrast, remains consistent in its inconsistency. Damning with faint praise, perhaps, but for the fact that Bohr recognizes in the concept of uncertainty the seed of all knowledge: when he imagines the end of the world, he envisions it as a time "when there's no more uncertainty, because there's no more knowledge" (Frayn 94). By refusing to neatly complete the act of translation for the audience, to tell them "what really happened," Frayn in fact empowers his audience to draw their own conclusions: to make observations, analyzes the data as they see

fit, and from there to create theories of their own. To act, in short, as scientists in their own right.

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